

524,695

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



15 FEB 2005



(43) International Publication Date  
26 February 2004 (26.02.2004)

PCT

(10) International Publication Number  
**WO 2004/016977 A1**

(51) International Patent Classification<sup>7</sup>: **F16L 19/02**,  
55/00, B25B 27/16, E21B 17/02

(21) International Application Number:  
PCT/NO2003/000283

(22) International Filing Date: 18 August 2003 (18.08.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
20023926 19 August 2002 (19.08.2002) NO

(71) Applicants (for all designated States except US): **MA-  
RINE DIRECT CONSULTANTS LTD.** [GB/GB];  
Westhill Business Park, Arnhall Business Park, Westhill,  
Aberdeenshire AB51 5LT (GB). **HÅMSØ, Gunnar**  
[NO/NO]; P.O. Box 171, N-4302 Sandnes (NO).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **GILES, John,**

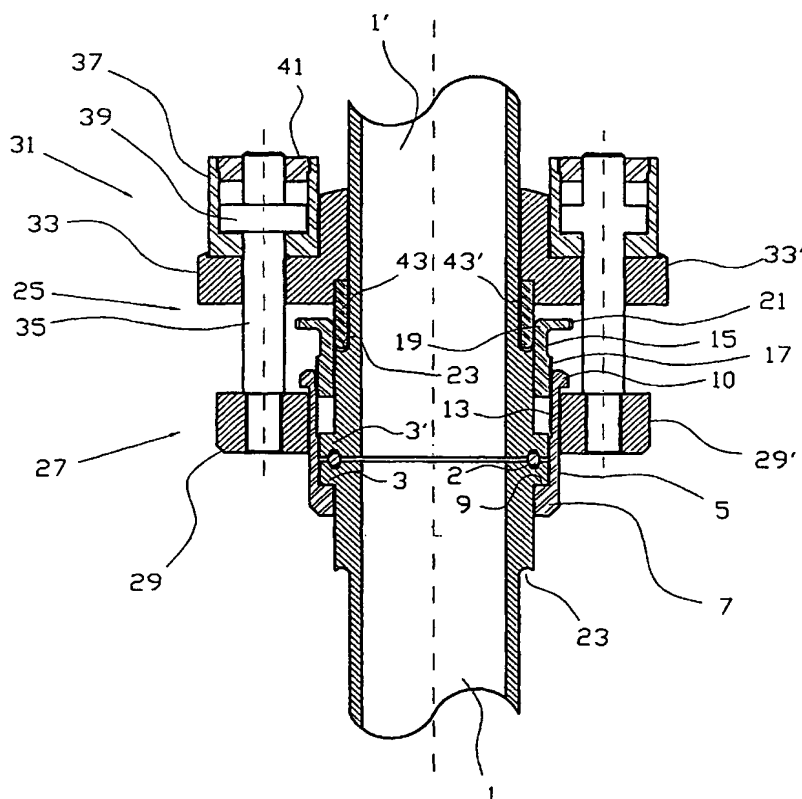
S. [GB/GB]; Moss Side House, East Blairdaff, Ab-  
erdeenshire, Aberdeenshire AB51 5LT (GB). **VORLEY,**  
**Stephen, W.** [GB/GB]; 6 Grampian Terrace, Torphins,  
Aberdeenshire, Aberdeenshire AB31 4JS (GB).

(74) Agent: **HÅMSØ PATENTBYRÅ ANS**; P.O. Box 171,  
N-4302 Sandnes (NO).

(81) Designated States (*national*): AE, AG, AL, AM, AT (util-  
ity model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA,  
CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (util-  
ity model), DE, DK (utility model), DK, DM, DZ, EC, EE  
(utility model), EE, ES, FI (utility model), FI, GB, GD, GE,  
GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ,  
LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN,  
MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO,  
RU, SC, SD, SE, SG, SK (utility model), SK, SL, SY, TJ,  
TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA,  
ZM, ZW.

[Continued on next page]

(54) Title: MEANS FOR CONNECTING PIPES COMPRISING AN AXIAL PRESS SURFACE TO TAKE AXIAL PRESSURE FROM A PRELOADING TOOL



(57) Abstract: A means of connecting pipes, comprising a seal (2), flanges (3, 3'), a threaded portion (15) and a nut (5), where the end portion (1, 1') of the pipe is equipped with a concentric press surface (23) located immediately proximal to the periphery of the pipe (1, 1') and designed to be able to take an axial pressure from a preloading tool (25), which pressure is distributed evenly or point-by-point about the periphery of the pipe. A means of compressing pipe couplings, where a preloading tool (25) comprises two end sections (27, 31) connected to two or more rods (35), each rod (35) being equipped with a hydraulic cylinder (37).

WO 2004/016977 A1



(84) **Designated States (regional):** ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

Means for connecting pipes comprising an axial press surface to take axial pressure from a preloading tool.

This invention regards a means of connecting pipes, particularly with a view to remotely operated and mechanized execution.

5 In petroleum production in particular, many extensive and demanding pipelaying operations are carried out both on shore and under water. Traditionally, work on underwater pipelines is carried out by divers; however the industry has advanced to a point where pipe lines are laid at depths which can not  
10 be reached by divers. Consequently, the work has to be carried out by remotely operated robots. Pipe joints to be joined by robots are often expensive.

In the case of land-based joining of pipes, the pipe joints are more readily accessible, but the process is still  
15 demanding.

The principal elements of any pipe joint are:

- Pipe fittings to bear and distribute the forces of compression caused by the surroundings, such as the water

pressure at great depths and/or the weight of the covering materials and also the axial loads caused by stretching and bending of pipes during and after laying;

- Coupling elements to keep the pipe fittings together;
- Seals to maintain a leak proof connection;
- A method of preloading the pipe joint where the applied load is greater than the combination of the compression energy taken up by the seal, the liquid or gas pressure in the pipe, and the stress from the surroundings.

10 When connecting pipes, it is important to keep control of the prestress level. If the prestress is too low, the joint may open up and leak when subjected to a high internal pipe pressure. If the prestress is set too high, the pipe joint may be overloaded.

15 Traditional pipe joints have been executed with bolted flanges, where a number of threaded bolts are distributed around the flange, and (a) seal(s) maintain(s) a tight connection. The bolts are tightened to the desired level in accordance with the load to be carried. When the bolt

20 tightening torque increases, the frictional forces during rotation of the nut become considerable.

For that reason, hydraulic jacking systems are to a certain extent used with large flanges in order to preload some of the pipe joint elements by placing a hollow jack over each

25 flange bolt and applying the specified pressure. The nuts are screwed in to the flange. The jack is relived and the load is transferred to the bolts. This method is preferred because it allows the possibility of controlling the load applied to the flange.

From US patent publication 4 150 477 there is known a method in which a prestress load is applied point by point to pipe flanges by means of hydraulic jacks, prior to the bolts being put in place and tightened. The disadvantage of this method  
5 of preloading is that the length of the pipe, which is subjected to axial elastic deformation, is very short. In addition, the point-by-point applied load gives unequal deformation along the circle of division of the boltholes.

The greatest disadvantage of most types of flange connections  
10 is that they include many parts and are difficult to work on using a remotely operated tool. In addition, a clearance for the preloading tool is required around the bolts, making it necessary for the bolts to be positioned at a distance from the pipe. Thus the flanges must be relatively thick in order  
15 to absorb the bending forces in the flange.

Other methods of connecting pipes use collars and clamps. The collars are welded to the pipe ends. The clamp is a large jointed device that is placed over the collars to force these together so as to activate the seal(s). The pre-stress is  
20 applied through one or two large bolts positioned at right angles to the longitudinal axis of the pipe pulling the clamp members together in the radial direction. Sliding surfaces between the clamp and the collars ensure that the pipe ends are pressed together. This system is easier to operate using  
25 a remotely operated tool, but the components are relatively heavy and expensive.

The object of the invention is to remedy the disadvantages of prior art.

The object is achieved in accordance with the invention by the characteristics given in the description below and in the appended claims.

A pipe joint according to the invention is constructed with the following main components:

a) Each pipe end comprises engagement and sealing surfaces that ensure guidance of the pipe ends during the connecting operation and give a tight connection.

b) One end of the pipe has a portion with a male thread, preferably in shape of a rotating threaded collar located behind a flange and preferably arranged to be forced against the flange by means of a preloading tool.

c) The opposite pipe end has a flange.

d) A nut is located behind the flange of the opposite pipe end. The rear portion of the nut has an internal surface of contact formed in a manner such that when the nut is carried out over the flange, the internal ledge at the rear edge of the nut abuts the radial rear face of the flange. An external flange is preferably located in the opposite end of the nut and preferably arranged to be forced against the flange by means of a preloading tool. The thread dimension of the nut corresponds to the male thread on the adjacent pipe end. The thread diameter is larger than the flanges of the pipe ends.

e) Each pipe end is arranged to allow a preloading tool to compress the pipe ends by gripping around the pipes and apply an axial directed movement. This preferably comprises a concentric press surface on one or both pipe ends immediately proximal to the pipe coupling parts and right up against the periphery of the pipe. These press surfaces are shaped to make a contact face for the preloading tool.

The elements a), b), c) and e) may be formed directly in the pipe material using the appropriate technology, or they may be formed in separate coupling parts that are connected to the end portions of the pipe using the appropriate *per se* technology.

The invention comprises the application of an axial load immediately proximal to the periphery of the pipe at and directly outside of the connection area, so that intermediate seals and pipe ends are subjected to elastic deformation. The pipes are joined with a nut coupling that absorbs a portion of the applied deformation forces. The pipe ends and the seals are compressed, and the nut couplings are tensioned with a combined clamping and joining tool.

A preloading tool comprises two moving end sections designed to grip respective pipes and an actuator designed to press each end section axially against the press surfaces of the pipe, the nut flange or the rear portion of the threaded collar thus pressing the pipe ends against each other.

Locking devices that are known *per se* are integrated into the end sections, keeping the preloading tool together when the tool encloses the pipe joint. Upon releasing the locks, the tool may be opened and led radially away from the pipe.

Preferably, the preloading tool comprises a nut runner equipped with preferably hydraulic driving means and a cog wheel that, when the tool is positioned around the pipe joint, catches external teeth on the nut or the threaded collar of the pipe joint.

The preloading tool is connected to a hydraulic system known *per se* comprising a pump, tank, operating valves, pressure control devices and more.

When connecting two ready-to-be-installed pipes, two opposite  
5 pipe ends are brought together using the appropriate  
manipulator equipment. The preloading tool is positioned over  
the pipe joint and closed. Then the end sections of the tool  
are pulled together so as to press against the press surface  
of one of the pipe ends and also against the nut flange or  
10 the threaded collar's rear portion. Then the load specified  
for the type of pipe in question is applied to the seal and  
the pipe section positioned between the two press surfaces.

The elastic compression of the preloaded area consists of:

- 1) The specified elastic compression of the seal at  
15 nominal work load.
  - 2) Additional compression in the seal during the  
preloading phase.
  - 3) Compression in the pipe ends between the press  
surfaces of the preloading tool during the preloading phase.
- 20 In addition an elastic extension of the nut alternatively an  
elastic compression of the male threads (integrated in pipe  
end or in collar) is applied.

At extension of the nut the collar is screwed into the  
blocked nut until abutment between the forward end of collar  
25 and the radial face of the corresponding pipe flange. At use  
of the alternative compression of the male threaded section  
the nut is screwed onto the male threads until abutment  
between the internal load bearing surface of nut and the  
radial face of the corresponding pipe flange.



The joining of nut and male threads is preferably accomplished mechanically, by activating a nut runner connected to or integrated in the preloading tool making the joint up to the specified torque. Then the preloading tool is relieved so as to partially transfer the load to the nut. Upon relief, the elastic deformation in the seal and pipe ends is reduced.

The rigidity of the nut coupling must be matched to the elasticity of the seal, so that the compression of the seal remains as specified for the nominal workload (ref. 1 in the former section) after relief.

In order for the seal to maintain its specified compression at the nominal work load, the extension of the nut coupling upon taking up the work load must not exceed:

4) the additional elastic compression applied to the seal during the preloading phase (= former point 2), plus

5) elastic compression in that portion of the pipe ends which is located between the working faces of the nut coupling against the pipe flanges.

It follows that the quality and dimensions of the nut materials must be closely matched to the elasticity of the seal.

It also follows that it is preferable to extend the nut and/or compress the threaded portion prior to joining, as this means that the nut coupling is already preloaded and tensioned before assuming the workload.

At use of a preloaded nut the extension of the joint is

caused by compression of the male threaded section. Due to the short distance to the pipe flange the total extension of the joint will approve relatively small.

At use of a preloaded male threaded section the extension of the joint is basically caused by the stretching of the nut. The nut is relatively long compared to the male threaded section, thus approving a larger extension of the joint.

After the workload has been transferred to the nut coupling, the preloading tool is opened and retracted from the coupling.

In the case of subsea work, the preloading tool is typically mounted on an ROV (Remotely Operated Vehicle). On shore, it may be integrated into a pipe laying equipment, suspended from a lifting tackle, be installed on a hydraulically operated lever arm, or similar.

The following describes a non-limiting example of a preferred embodiment illustrated in the accompanying drawings, in which:

Figure 1 shows a joined pipe coupling;

Figure 2 shows a pipe coupling ready to be joined, with the preloading tool placed near the coupling (the drawing only shows one half of the preloading tool);

Figure 3 shows the preloading tool closed around a pipe coupling;

Figure 4 shows a longitudinal section through a pipe coupling with a preloading tool prior to preloading and joining (the nut runner is not shown);

5 Figure 5 shows a longitudinal section through a joined pipe coupling with the preloading tool in the contracted position (the nut runner is not shown);

Figure 6 shows a cross section through a pipe coupling and preloading tool;

10 Figure 7 shows a longitudinal section made through the nut runner of the preloading tool;

Figure 8 shows a cross section through the nut runner of the preloading tool;

15 Figure 9 shows a longitudinal section through a pipe coupling with the preloading tool partially retracted from the coupling; and

Figure 10 shows a cross section through a pipe with the preloading tool partially retracted from the pipe coupling.

20 In the drawings, reference number 1, 1' denotes end portions of two pipes. Between the pipe ends 1, 1', a seal 2 is placed in appropriate grooves. One end portion 1 is equipped with a flange 3 and a nut 5. The nut 5 comprises a rear portion 7 with an internal load bearing surface 9 that corresponds to the flange 3. The nut 5 is provided with an external flange 10. Internally, the nut 5 is provided with a threaded portion 13.

25

The other end portion 1' is equipped with a flange 3' and a threaded collar 15 with a male thread portion 17 that corresponds to the threaded portion 13 of the nut 5. The rear portion 19 of the threaded collar has external teeth 21.

- 5 The end portions 1, 1' are equipped with a concentric, predominantly radial press surface 23.

A preloading tool 25 comprises a first end section 27. This is made up of two section parts 29, 29'. The second end section 31 is made up of two section parts 33, 33'. Two or  
10 more rods 35 with associated hydraulic cylinders 37, piston 39 and seals (not shown) connect the section parts 29, 33 and 29', 33'. The cylinder is fitted with a detachable gland 41 and seals (not shown).

15 Preferably, the section parts 33, 33' are provided with a replaceable clamping profile 43, 43' that corresponds to the profile of the press surface 23.

The section parts 29, 33, respectively 29', 33', joined by the rods 35 are separately connected to a device (not shown) that by means of e.g. hydraulic force may open and close the  
20 preloading tool primarily through radial movement relative to the pipe 1, 1'.

In the closed position around the pipe 1, 1', the preloading tool 25 may be kept closed by use of suitable locking devices (not shown).

- 25 Preferably, the preloading tool 25 comprises one or more nut runners 45 equipped with driving means 47, as an example a

hydraulic motor, and a cog wheel 49 that corresponds to the teeth 21 on the threaded collar 15.

The hydraulic cylinders 37 of the preloading tool 25 are connected up to a hydraulic system (not shown) with an associated pump, tank, valves and control devices.

Coupling of pipes may take place through remote operation of the preloading tool 25. When two pipes have been placed with their corresponding ends 1, 1' sufficiently close to each other through the use of suitable means, and the preloading tool is guided over the end portions 1, 1'. The preloading tool 25 is closed around the end portions 1, 1' by the section parts 29, 29', 33, 33' being moved radially towards the end portions 1, 1'. The end section 27 is pressed against the external flange 10 and the end section 31 is pressed against the end portion 1', so that the press surface 23 coincides with the clamping profile 43, 43' by the operating and control device of the hydraulic system (not shown) carrying the hydraulic cylinders 37 in the correct direction with a pressure adjusted according to the joint dimension in question.

When the end portions 1, 1', the seal 2 and the nut 5 have been subjected to the load specified for the pipe joint dimension, the end portions 1, 1' are held together while the threaded collar 15 is made up to the specified torque.

The threaded collar 15 is preferably tightened with the nut runner 45. This takes place through the cog wheel 49, which abuts the corresponding teeth 21 of the threaded collar 15, being driven with a specified torque by the driving means 47 of the nut runner 45.

When the threaded collar 15 has been tightened, the pressure on the preloading tool 25 is relieved, so as to transfer the load to the nut 5 and the threaded collar 15. The preloading tool 25 is opened, retracted from the completed pipe joint, and prepared for the next coupling.

## C l a i m s

1. A means of connecting pipes, comprising a seal (2),  
flanges (3, 3'), a threaded portion (17) and a nut (5),  
c h a r a c t e r i s e d i n that the end portion (1,  
5 1') of the pipe is equipped with a concentric press  
surface (23) located immediately proximal to the  
periphery of the pipe (1, 1') and designed to be able to  
take an axial pressure from a preloading tool (25),  
which pressure is distributed evenly or point-by-point  
10 about the periphery of the pipe.

2. A means in accordance with Claim 1,  
c h a r a c t e r i s e d i n that the nut (5) has a  
flange (10) designed to be able to take an axial  
pressure from the preloading tool (25), which pressure  
15 is distributed evenly or point-by-point about the  
periphery of the nut (5) and directed towards the pipe  
flange (3).

3. A means in accordance with Claim 1,  
c h a r a c t e r i s e d i n that a threaded collar's  
20 (15) rear portion (19) is designed to be able to take an  
axial pressure from the preloading tool (25), which  
pressure is distributed evenly or point-by-point about  
the periphery of the collar (15) and directed towards  
the pipe flange (3').

4. A means in accordance with one or more of the previous  
25 Claims, c h a r a c t e r i s e d i n that the  
threaded collar's (15) rear portion (19) has a toothed  
periphery.

5. A means in accordance with one or more of the previous Claims, characterised in that the nut's (5) rear portion (7) has a toothed periphery.

5 6. A means of compressing pipe couplings comprising two concentric press surfaces (23) designed to be able to take an axial pressure, characterised in that a preloading tool (25) comprises two end sections (27, 31) connected to two or more rods (35), each rod (35) being equipped with a hydraulic cylinder (37).

10 7. A means in accordance with Claim 6, characterised in that the preloading tool (25) comprises a nut runner (45).

15 8. A means in accordance with Claims 6 and 7, characterised in that the nut runner (45) is equipped with a cogwheel (49) allocated to the rotation of a threaded collar (15) with a toothed periphery of the rear portion (19).

20 9. A means in accordance with Claims 6 and 7, characterised in that the nut runner (45) is equipped with a cogwheel (49) allocated to the rotation of a nut (5) with a toothed periphery of the rear portion (7).



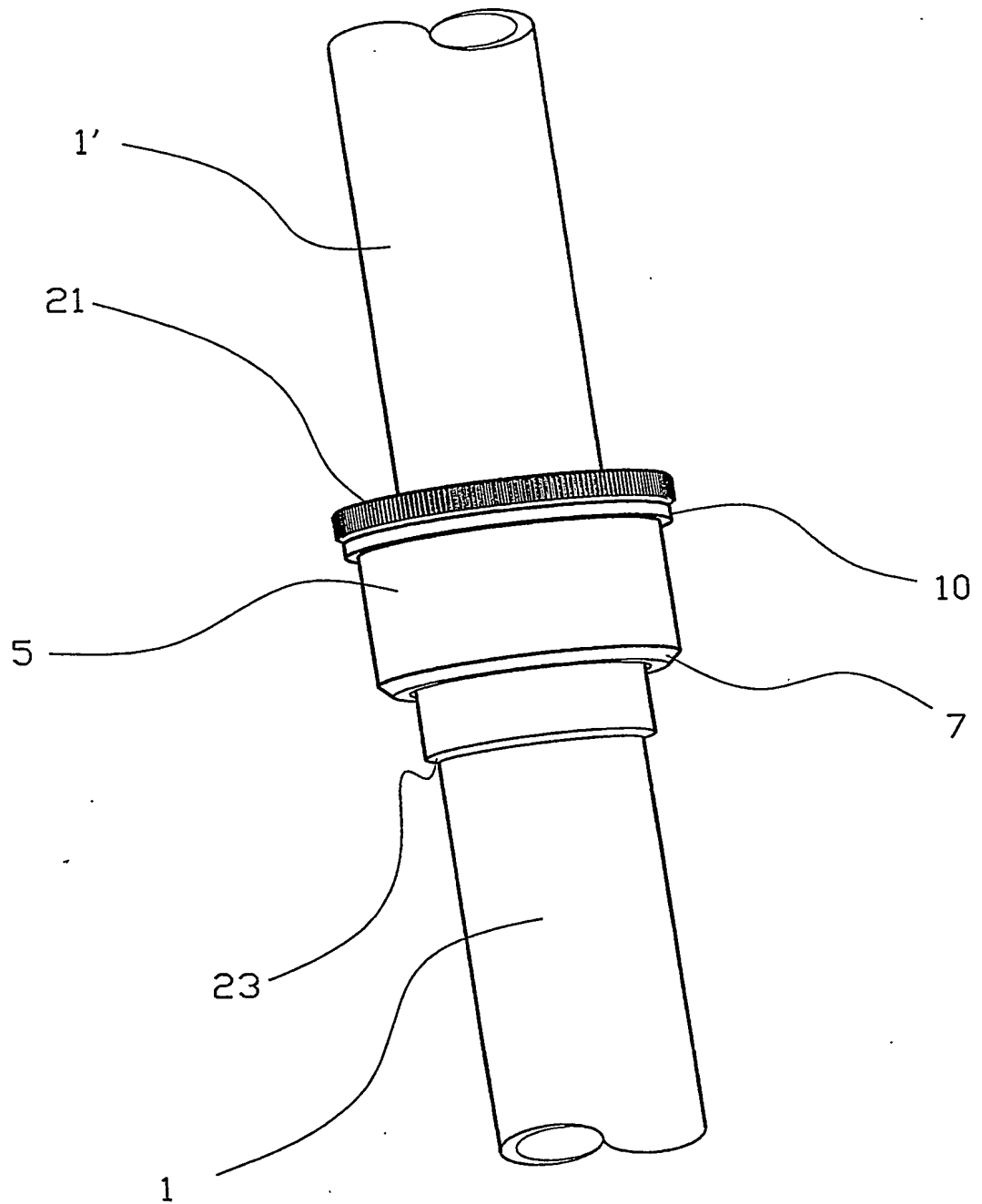


Fig. 1

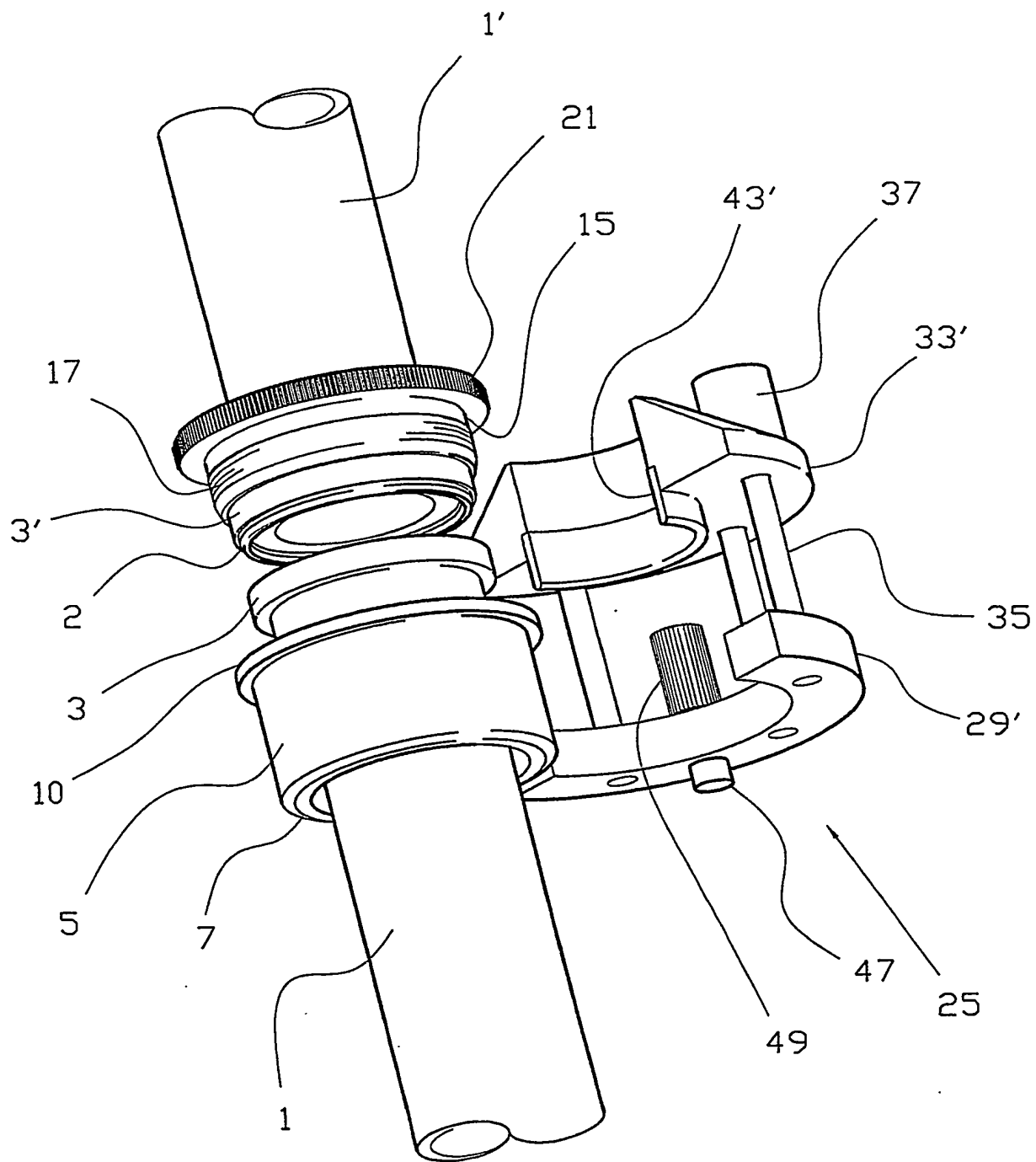


Fig. 2

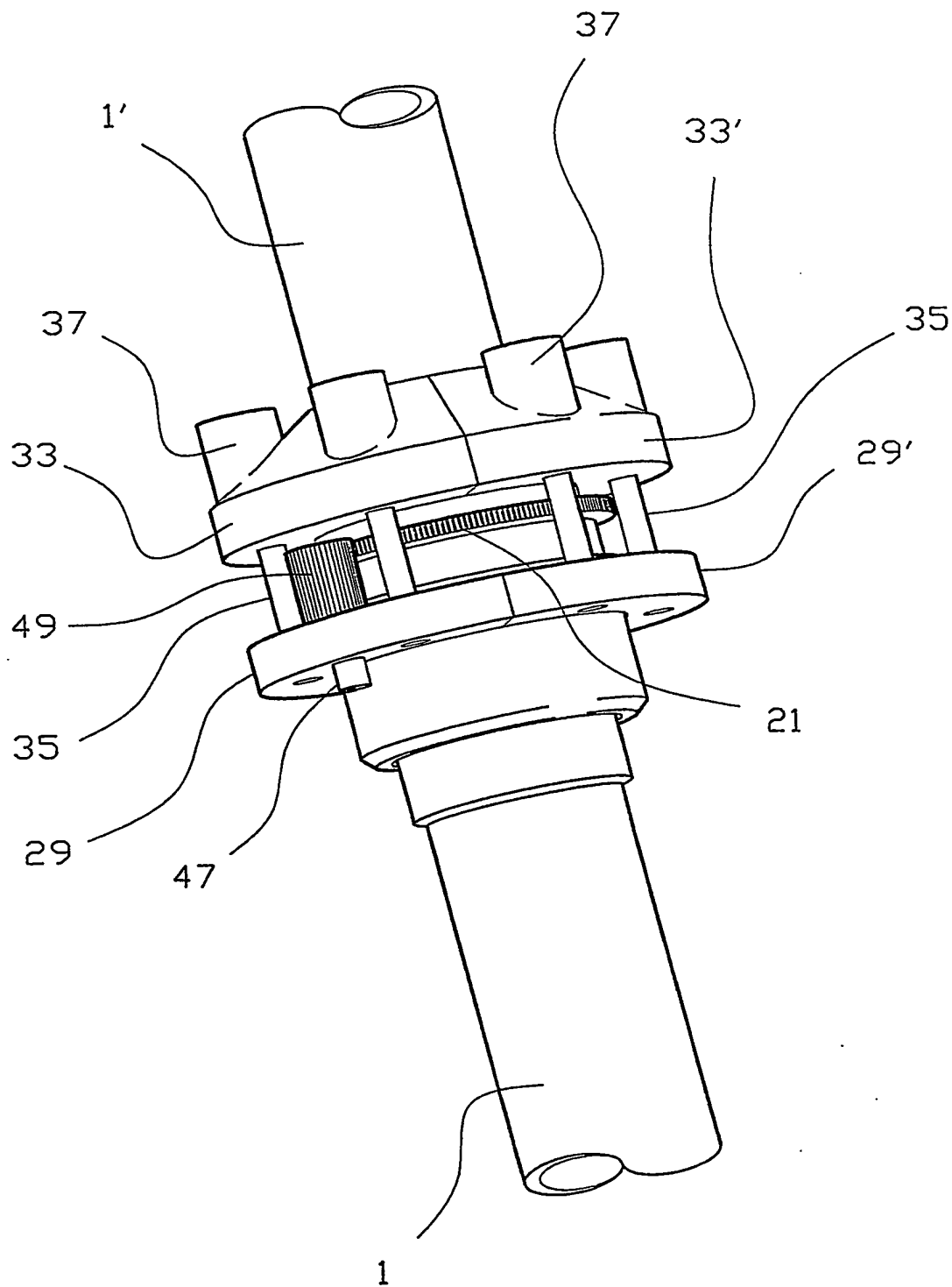


Fig. 3

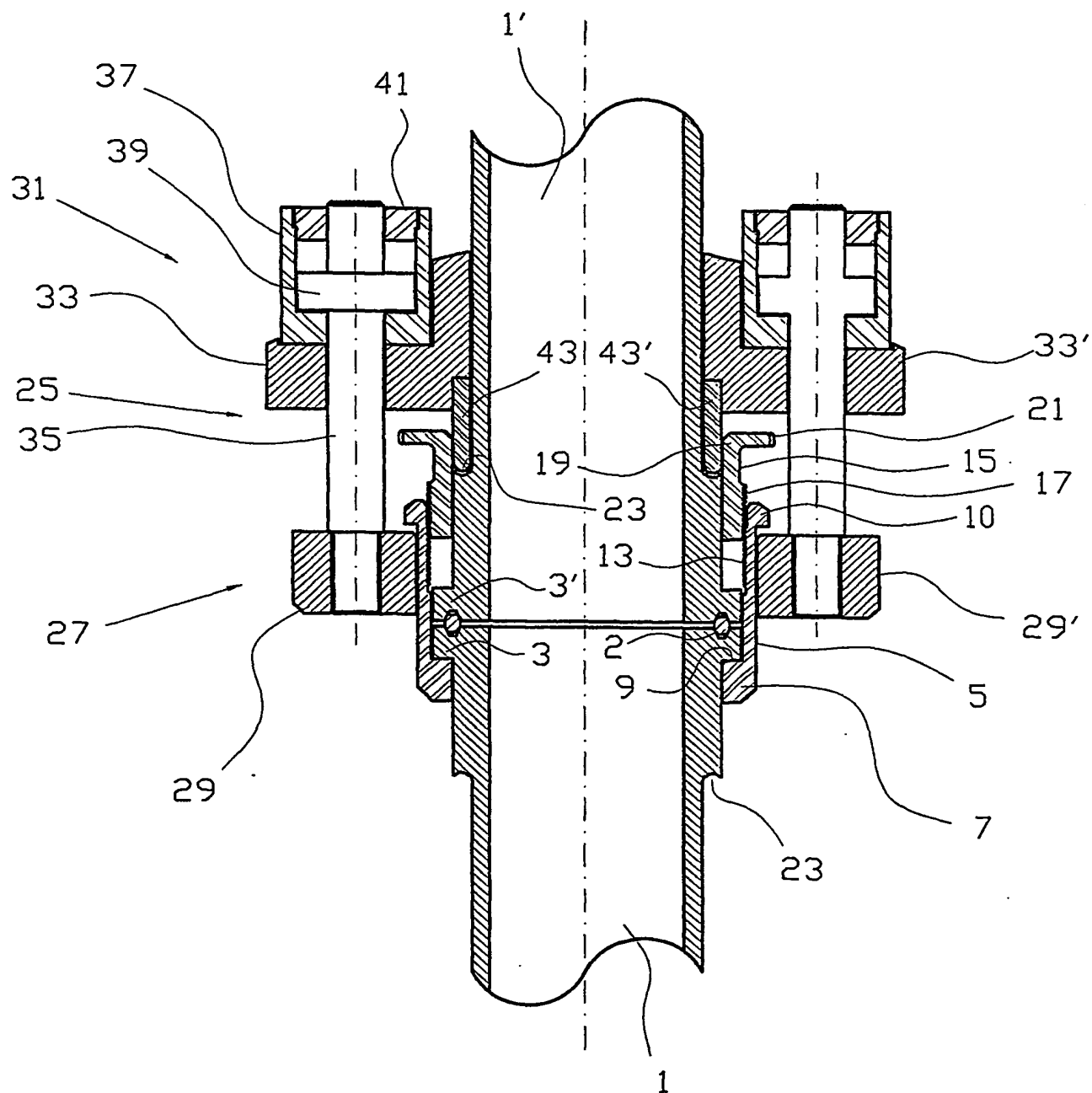


Fig. 4

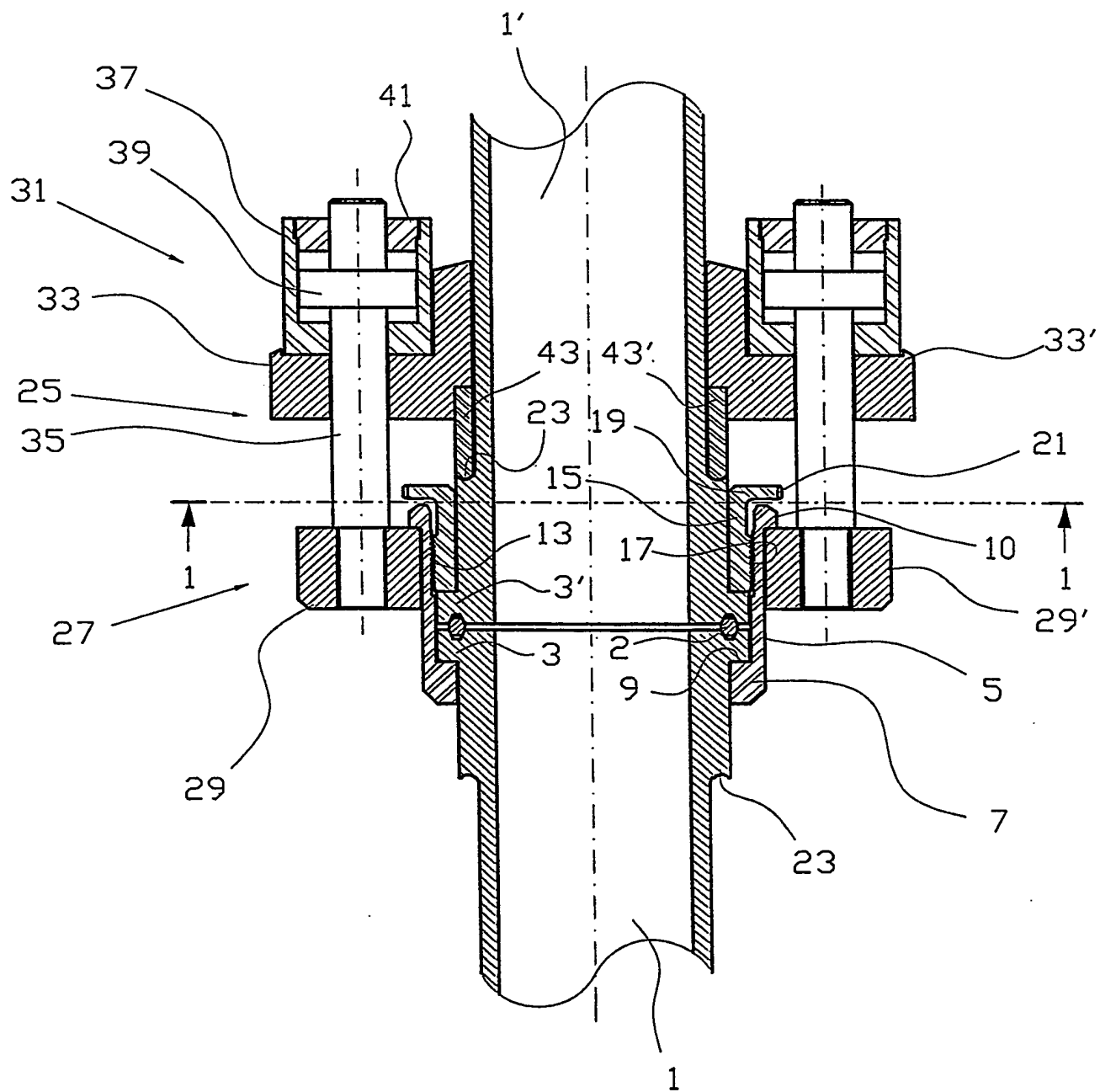
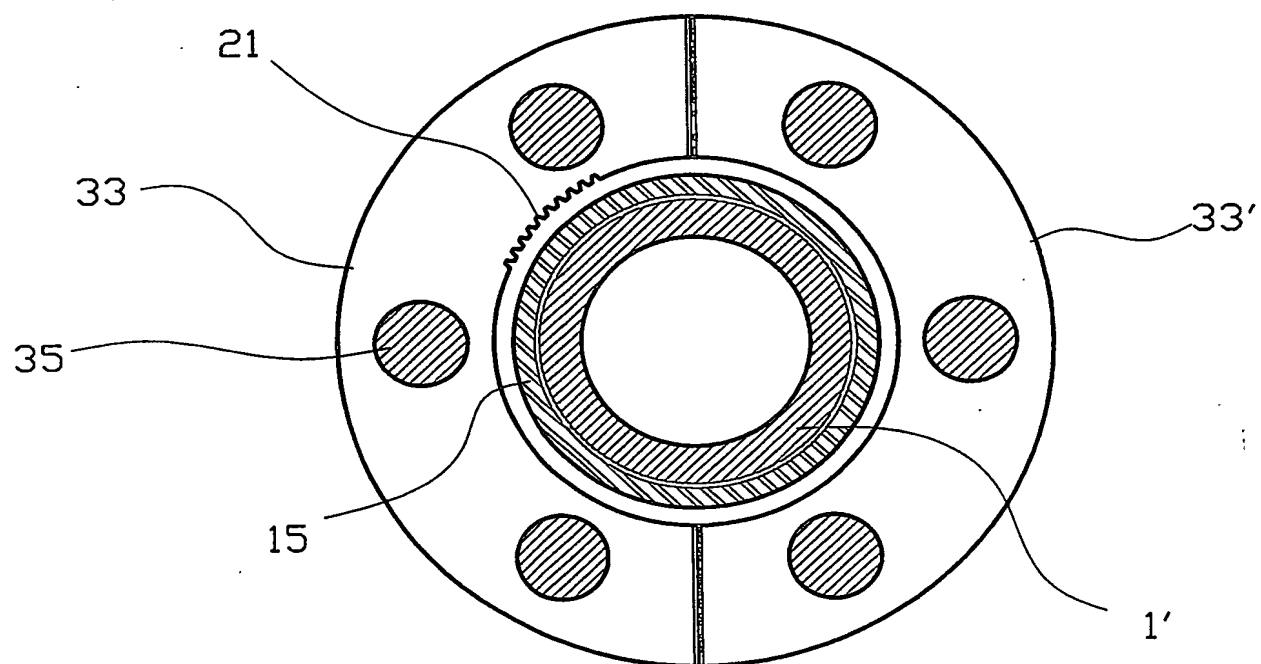


Fig. 5



Cross section 1-1

Fig. 6

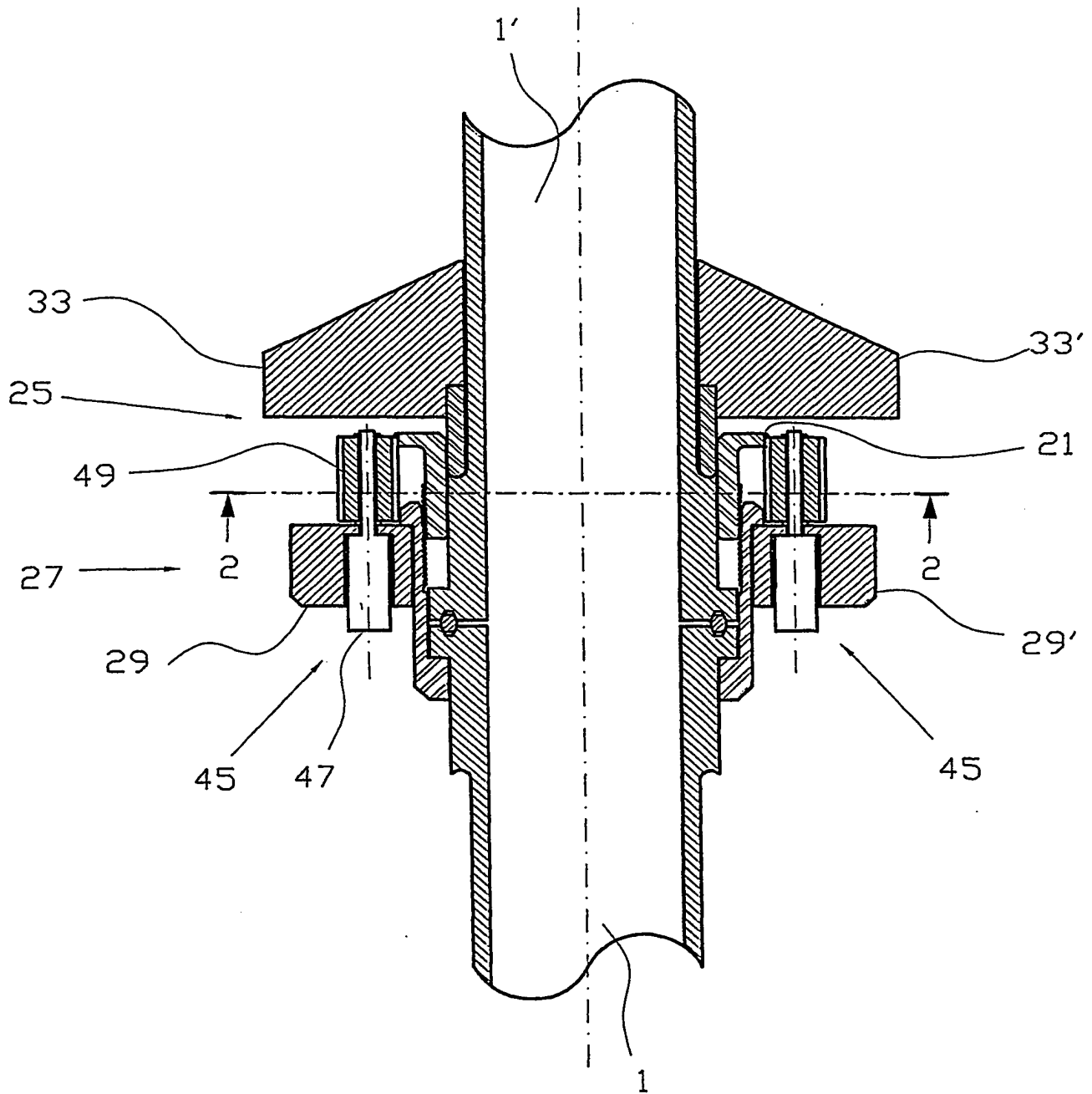
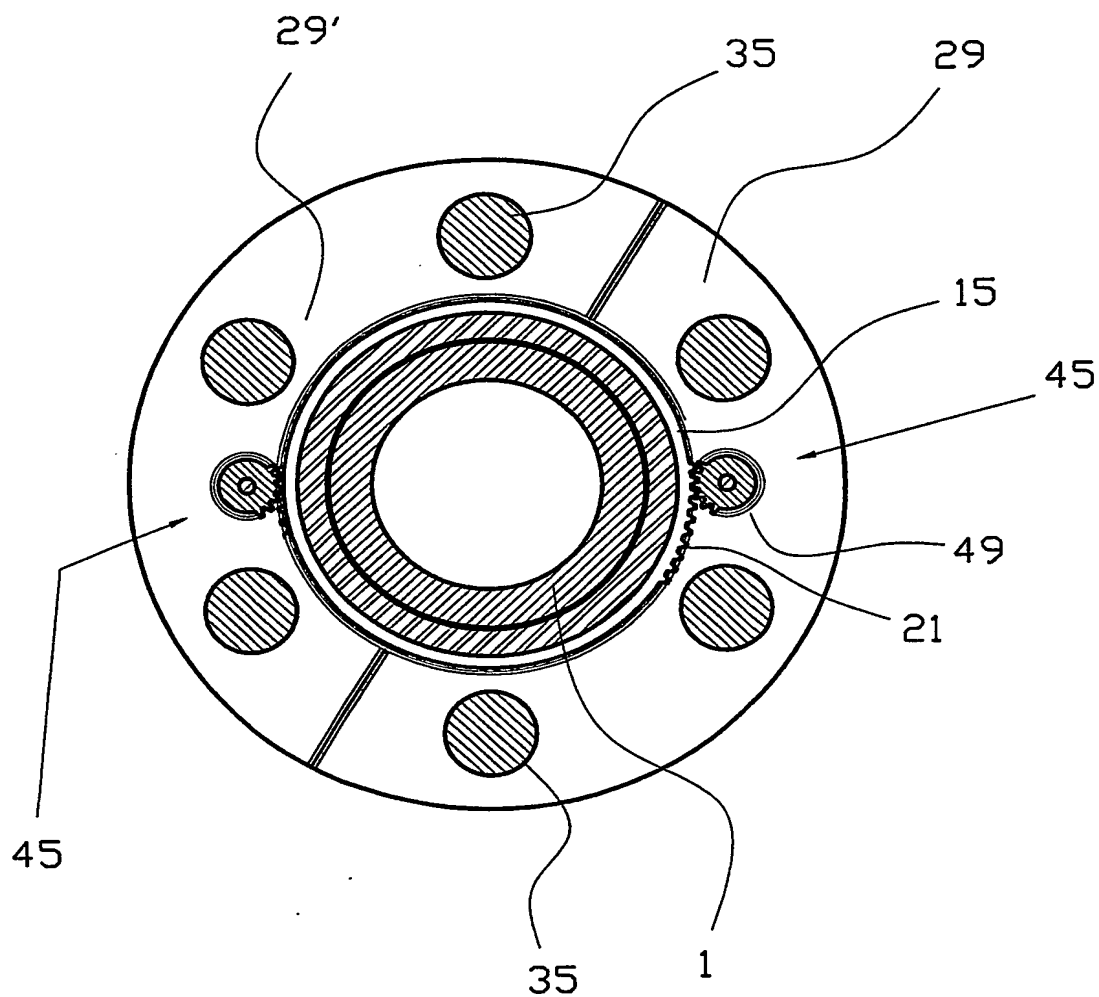


Fig. 7



Cross section 2-2

Fig. 8



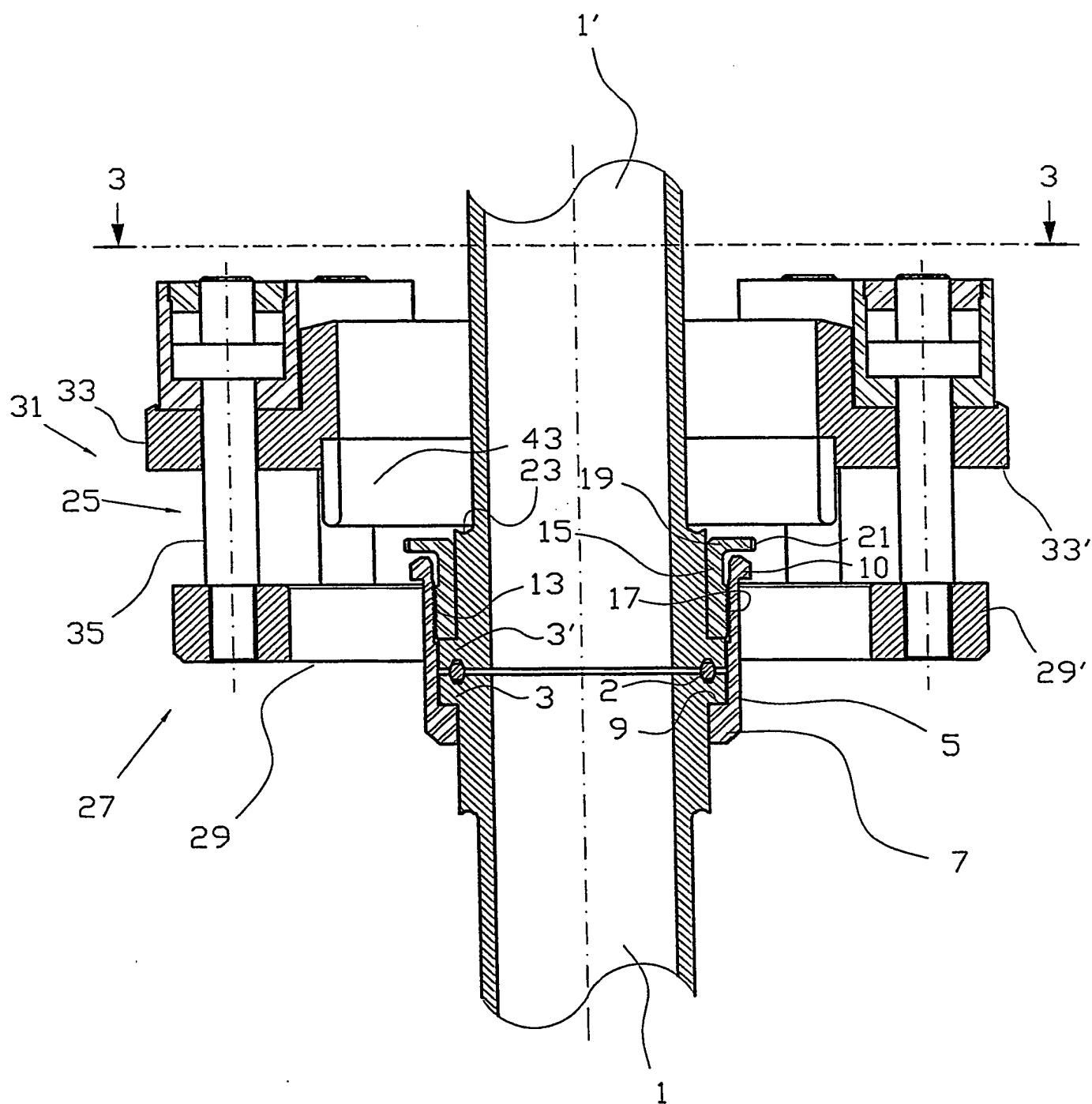
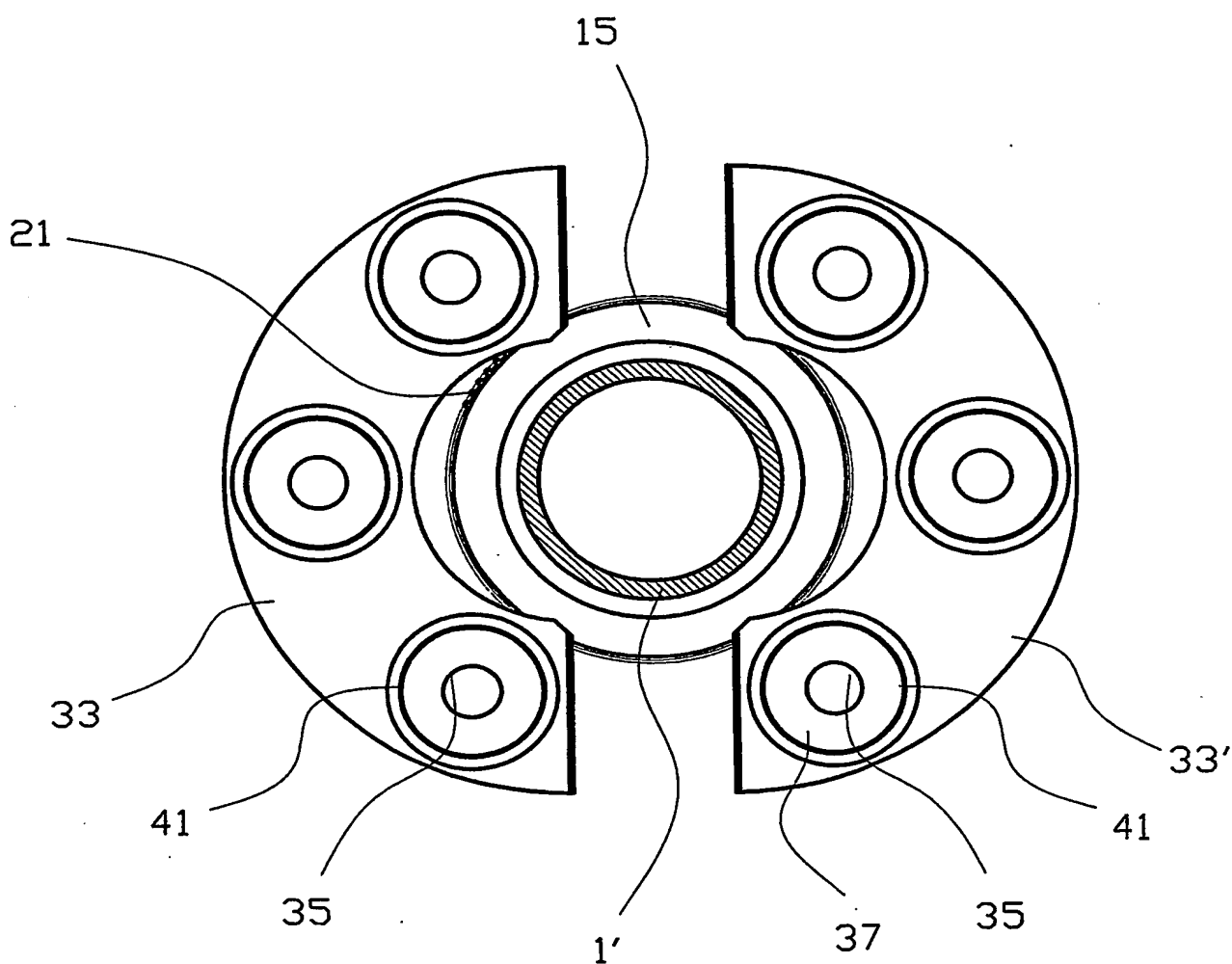


Fig. 9



Cross section 3-3

Fig. 10

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 03/00283

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F16L 19/02, F16L 55/00, B25B 27/16, E21B 17/02  
According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F16L, E21B, B25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4012059 A (LUKE ET AL), 15 March 1977 (15.03.77), figure 1, details 24,27,45,47,50,53	1-6
Y	--	7-9
Y	US 3353847 A (C.C. BROWN), 21 November 1967 (21.11.67)	7-9
Y	GB 707988 A (ERIC COOKSON), 28 April 1954 (28.04.54)	7-8
X	US 4153281 A (AHLSTONE), 8 May 1979 (08.05.79), figures 1,6, details 1-4,21,37,39,T	1,6
	--	

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

\* Special categories of cited documents

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

22 October 2003

Date of mailing of the international search report

24-10-2003

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Malin Hallmén / JA A

Telephone No. +46 8 782 25 00

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 03/00283

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>US 4093281 A (JANSEN, JR.), 6 June 1978 (06.06.78)</p> <p style="text-align: center;">-- -----</p>	1,6

# INTERNATIONAL SEARCH REPORT

Information on patent family members

06/09/03

International application No.

PCT/NO 03/00283

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	4012059	A	15/03/77	DE	2640198 A,C	17/03/77
				FR	2323088 A,B	01/04/77
				GB	1501577 A	15/02/78
				JP	52048835 A	19/04/77
				MY	2279 A	31/12/79
-----						
US	3353847	A	21/11/67	NONE		
-----						
GB	707988	A	28/04/54	NONE		
-----						
US	4153281	A	08/05/79	NONE		
-----						
US	4093281	A	06/06/78	NONE		
-----						